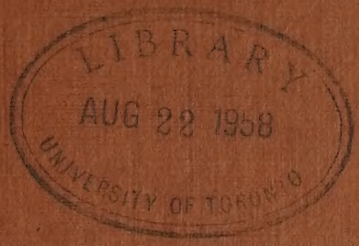


HYDRO-ELECTRIC INQUIRY COMMISSION

ENGINEERING DATA

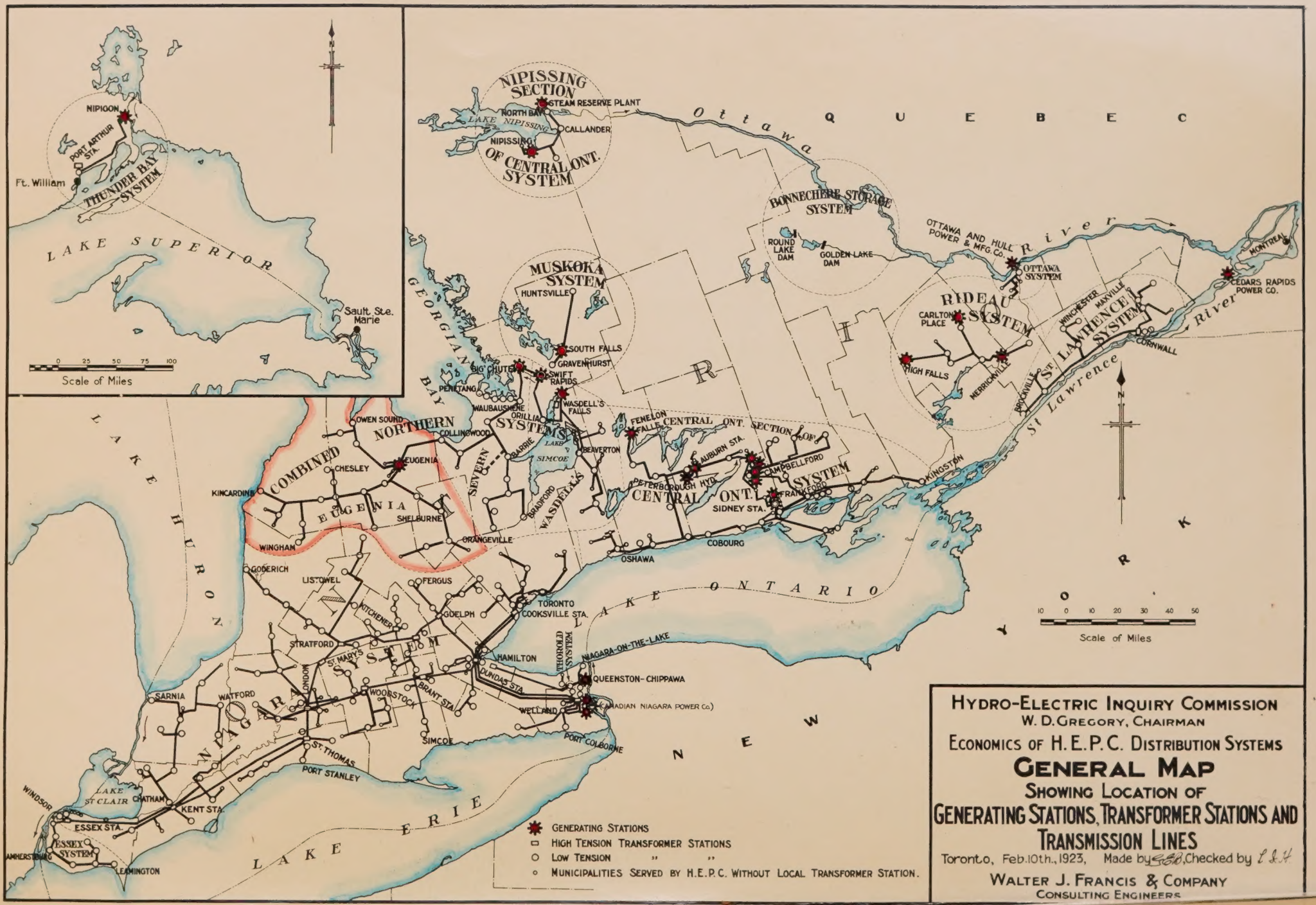
ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

STUDY OF EUGENIA SYSTEM

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

EUGENIA SYSTEM



HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

GENERAL MAP

SHOWING LOCATION OF

GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES

Toronto, Feb. 10th., 1923, Made by S.S.B., Checked by L.S.H.

WALTER J. FRANCIS & COMPANY

CONSULTING ENGINEERS

Mr. J. Allan Ross.

To face frontispiece.

General Map Showing Location of

Generating Stations, Transformer Stations and Transmission Lines

of the

Hydro-Electric Power Commission of Ontario.

The area outlined in red shows the

Eugenia System.

(Index)

INDEX TO EUGENIA SYSTEM

INDEX TO EUGENIA SYSTEM

(Illus.)

LIST OF ILLUSTRATIONS

EUGENIA SYSTEM

Toronto, Ontario,

February 12th, 1923.

Hydro-Electric Inquiry Commission,
W. D. Gregory, Esq., Chairman,
T O R O N T O, Ontario.

re Studies of Engineering Economics of the
Eugenia System of the
Hydro-Electric Power Commission of Ontario

Mr. Chairman and Gentlemen,-

In accordance with the letter to your Commission under date of November 4th, 1922, and your confirmation of the general instructions under date of November 15th, 1922, a study has been made of the engineering economics of the Eugenia System of electrical generation and distribution operated by the Hydro-Electric Power Commission of Ontario. The work has been done under the direct personal supervision of Mr. Frederick B. Brown, M. Sc., M.E.I.C., a partner in the firm of Walter J. Francis & Company, in accordance with your instructions.

The subject has been discussed with Mr. Commissioner H. A. Ross in detail, and, generally, with Mr. Bower, the Secretary of your Commission, and constant communication has been maintained with the officials of the Hydro-Electric Power Commission of Ontario.

The reports of Messrs. Price, Waterhouse & Co. have been used as the basis of the financial figures given herein, and reference has been made to the records of the Hydro-Electric Power Commission of Ontario where it was necessary to do so to prepare the diagrams.

It is understood that it is not within the scope of the instructions to examine into any of the legal aspects of the System nor discuss any of the Acts of the Legislature relating to it.

The necessary technical data has required considerable preparation, as much of it is only available in the operating records of the Hydro-Electric Power Commission of Ontario. The printed reports contain a part, but these have had to be supplemented by interviews with various officials, and by searching the voluminous records both at the head office in Toronto and elsewhere.

The general plan under which the report of the studies is presented may be outlined as follows:

(1) A short review of the history and evolution of the System.

(2) A brief physical description of the System.

(3) A brief discussion regarding the characteristics of the local market.

(4) A discussion of progressive capital costs.

(5) Statistics regarding progressive revenues for various classes of service, with discussion thereon.

(6) Statistics regarding progressive operating costs and fixed charges, with discussion thereon.

(7) Statistics showing progressive and accumulated deficits or surpluses, with discussion thereon.

(8) Analysis of progressive operating records and of unit revenues per kilowatt hour and per horse-power per annum and of unit costs per kilowatt hour and per horse-power per annum.

(9) A brief discussion of the various important points concerning the System.

The report included herewith as pages 4 to 55 inclusive refers in detail to that portion of the activities of the Hydro-Electric Power Commission known as the Eugenia System. References are made to the inter-connection of this System with other Systems.

Throughout the report diagrams have been included in the order of the text, while the map included as a frontispiece shows the System generally and its geographical relation to all the other Systems operated by the Hydro-Electric Power Commission of Ontario.

EUGENIA SYSTEM

Frederick B. Brown, M. Sc.

Evolution and Development of the System.

The Eugenia System is the result of taking over the activities of certain private companies and the gradual development of electrical service since these companies were obtained.

About the year 1910, it is stated by officials of the Hydro-Electric Power Commission of Ontario, pressure was commencing to be exerted by certain municipalities in the district to the end that a municipally-owned enterprise be developed similar to that which was in operation in the Niagara District.

In the year 1911 a preliminary report on a source of power at Eugenia Falls was made for the Hydro-Electric Power Commission from data collected by the Georgian Bay Power Company. The engineers of the Hydro-Electric Power Commission state that in 1913 certain of the municipalities asked the Commission to proceed, saying that Eugenia Falls was a dependable power site. A sharp-crested weir was built in 1913 and a recorder was employed to obtain continuous flow records. On October 27th, 1913, a contract was signed with the municipality of Owen Sound for the supply of 1,200 horse-power, following which the Commission applied for an Order-in-Council to permit the purchase of the Georgian Bay Power Company, and to develop the water power on the Beaver River. The Order-in-Council was approved by the Lieutenant-Governor on November 6th, 1913, and the designs for the development at Eugenia Falls

were proceeded with. On May 5th, 1914, there was purchased from the Georgian Bay Power Company, for the sum of $60,000.00, all the lands of the Company (with the exception of a small parcel of 3.44 acres which was granted and conveyed as a leasehold), the franchise, and the water power in the vicinity of Eugenia Falls on the Beaver River. It is understood that the Commission also purchased about 1,525 acres of land and expropriated 175 acres for the purpose of forming local ponds, and that after the construction of two dams on this property practically the whole area was flooded.

The Eugenia Falls generating station was constructed on the properties so acquired and was put into operation on November 18th, 1915, having a rating of 3,200 horse-power according to the Hydro-Electric Power Commission practice. The power generated was transformed for transmission to the various municipalities from 4,000 volts to 22,000 volts.

On February 10th, 1916, it is stated that the Commission entered into an agreement with the Pine River Light & Power Company for the purchase of the Orangeville, Shelburne and Horning's Mills Systems for the sum of $43,570.00. The properties included certain station equipment, exclusive of buildings, in the town of Orangeville and in the villages of Shelburne and Horning's Mills, as well as certain transmission lines from the power house near Horning's Mills and the lighting system within the limits of Horning's Mills. In the latter part of 1916 a tie line connecting the Eugenia System with the Severn System was completed to permit of the mutual transfer of power between the two Systems, and, since that time, the Eugenia System has supplied a certain amount of surplus power to the Severn System, and vice versa.

In 1917 the load demand on the Eugenia System was stated to have increased

to such an extent that it was considered necessary to increase the capacity of the Eugenia Falls generating station by the addition of a generating unit giving an additional amount of 3,200 horse-power, thus doubling the capacity of the original plant. This unit was placed in service on February 29th, 1920.

Up to October 31st, 1921, the System comprised, either by purchase or construction, a total of 295.7 miles of transmission lines, and at October 31st, 1922, was serving twenty-three municipalities. In 1922 certain lines were added to the above mileage, but the details of these are not yet available.

Included in the Eugenia System are a number of rural lines which consist of primary transmission lines and cables to supply electrical energy to rural customers adjacent to certain municipalities in the Eugenia System. At October 31st, 1921, it is understood rural lines were operated by the municipalities of Markdale and Flesherton, which collected the revenues and maintained the lines, paying the Commission for interest and sinking fund based on the capital invested in the lines. These rural lines are supposed to become the property of the municipalities operating them when the accumulated sinking fund payment will be sufficient to repay to the Commission the investment in the lines.

The Ontario Government has a special Act, known as the Rural Hydro-Electric Distribution Act, 1921, whereby it may provide up to one-half the capital necessary for primary rural lines under certain conditions. Section 4 of the Act reads as follows:

"Where power is supplied to a rural power district under the provisions

of the Power Commission Act and amendments thereto, there may be paid to the municipality or commission distributing the power in such rural power district upon the recommendation of the Hydro-Electric Power Commission of Ontario, and the order of the Lieutenant-Governor in Council, a sum not exceeding fifty per cent. of the capital cost of constructing and erecting in the rural power zone, primary transmission lines and cables required for the delivery of power in such rural power district."

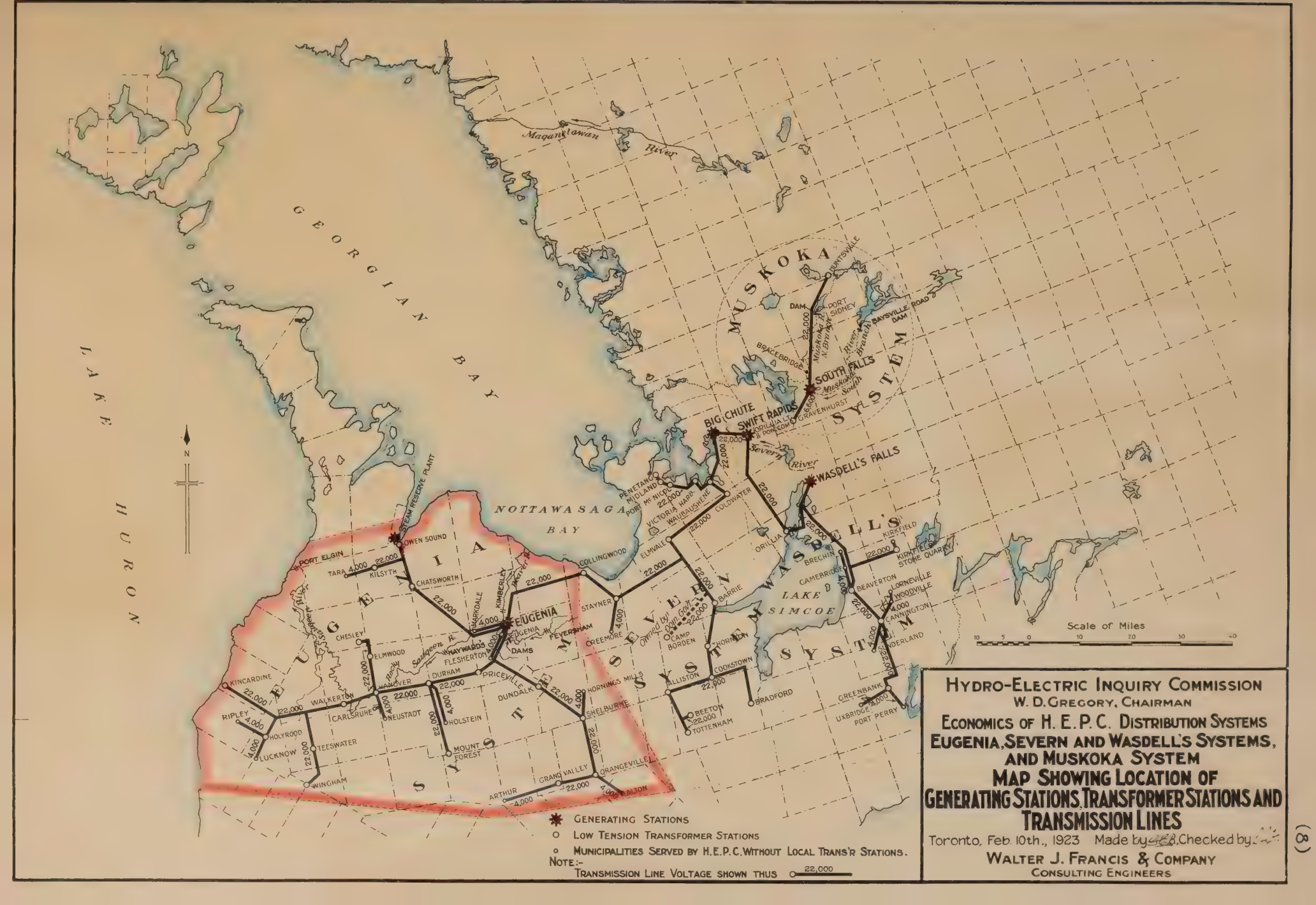
Description of the System.

General.

The Eugenia System lies north of the Niagara System and west of the Severn System. Its extent is about 50 miles north and south and 75 miles east and west, and it lies to the south of Georgian Bay and to the east of Lake Huron and covers portions of the Counties of Grey, Dufferin and Bruce.

The map included as a frontispiece shows the whole of the transmission systems of the Hydro-Electric Power Commission of Ontario with the location of generating stations, high tension transformer stations, high tension transmission lines and low tension transformer stations clearly indicated, and shows the various systems in their relation to one another. The tinted portion of the map indicates the Eugenia System.

The map included as page 9 shows the Eugenia System on a larger scale than the frontispiece and gives also the names of the principal centres concerned. It shows also the Severn and Wasdell's Systems which are interconnected with the Eugenia System for convenience of operation, these three systems together being known in the records of the Hydro-Electric Power



HYDRO-ELECTRIC INQUIRY COMMISSION

W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS EUGENIA, SEVERN AND WASDELL'S SYSTEMS, AND MUSKOKA SYSTEM

MAP SHOWING LOCATION OF GENERATING STATIONS, TRANSFORMER STATIONS AND TRANSMISSION LINES

Toronto, Feb. 10th., 1923 Made by H.E.B. Checked by:

WALTER J. FRANCIS & COMPANY
CONSULTING ENGINEERS

Commission of Ontario as the Combined Northern Systems.

Speaking generally, the Eugenia System consists of a hydro-electric generating plant on the Beaver River at Eugenia Falls, a tie line to permit of interchanging power with the Wasdell's and Severn Systems, and transmission lines feeding twenty-three municipalities, and some rural lines.

Generating Station and Other Sources of Power Supply.

The only generating station at present constructed on the Eugenia System is that at Eugenia Falls on the Beaver River. This plant utilizes a static head of about 540 feet, this being one of the highest heads developed in Canada. The net head on the turbines, after allowing for friction and other losses, averages about 524 feet, while the minimum head is about 515 feet. The watershed of the Beaver River above this site is about 75 square miles. A concrete dam about 2,000 feet long and about 51 feet high above the Falls provides a local storage of approximately 740,000,000 cubic feet, from which the impounded water is led through a canal about 5,000 feet long to a smaller pond formed by a second dam of the earth-filled type about 800 feet long by 30 feet high. In this second dam is a reinforced concrete gate house with provision for two pipe lines, one of which is now installed. This pipe is of wood stave construction, 46 inches in diameter and 3,350 feet long. It is controlled by a 58-inch, electrically-operated, butterfly valve, and terminates in a surge tank near the brow of the escarpment, whence a 52-inch steel penstock, about 1,559 feet is length descends to the power house, ending in a 50-inch butterfly valve installed near the turbine. The power house as

originally constructed contained two 2,850 horse-power turbines, each directly connected to a 1,411 K.V.A.,900 r.p.m., 3-phase, 60-cycle, 4,000-volt, horizontal-type generator, with a direct-connected exciter. The Hydro-Electric Power Commission rating or capacity of each of these two units is 1,600 horse-power.

Dam No. 1 was constructed by the Ambursen Hydraulic Construction Company, of Montreal. Dam No. 2, the canal, the excavation for the pipe line, the headworks and the power house were constructed by the Hyland Construction Company of Toronto; the pipe line was built by the Pacific Coast Pipe Company, of Vancouver, the surge tank by the Canadian Allis-Chalmers Company, the penstocks by the Thor Iron Works, and the turbine by the Escher-Wyss Company, of Zurich, Switzerland. It is stated that the power house plans were not completed when the above contracts were let because the hydraulic and electrical details were not then available from the machinery makers. The general contractors, the Hyland Construction Company, were given the work of constructing the power house on force account, the reason given being that the structure had comparatively small quantities contained in it, and the contractor was on the work with everything necessary to go ahead, and that it was necessary to avoid delays in completion. The contract for the superstructure of the power house was awarded to Witchall & Sons, Toronto.

This is stated to be the second generating station constructed by the Hydro-Electric Power Commission, Wasdell's Falls being the first, and this, the Eugenia station, was placed in commercial operation on November 18th, 1915.

Early in 1917 the load demands on the Eugenia System had increased to such an extent that it is stated it was decided by the Hydro-Electric Power Commission to increase the capacity of the generating station. On June 7th, 1917, a contract was let to the Allis-Chalmers Company, of Milwaukee, for a single-runner turbine to deliver 4,000 horse-power at 720 r.p.m. under a head of about 550 feet. It is understood that this unit was designed to operate on water to be supplied by the same pipe line which supplies the two original units.

The electrical equipment in connection with the extension to the plant was purchased from the Canadian Westinghouse Company. The generator is a horizontal, direct-connected, water-wheel-driven type of 2,820 K.V.A. maximum rating at 85% power factor, three-phase, 60-cycles, 4,000 volts, 720 r.p.m., and has a 40 kilowatt, 125-volt, direct connected exciter. Three 900 K.V.A., 4,000-volt to 22,000-volt single phase transformers were also purchased from the Canadian Westinghouse Company. Low-voltage and high-voltage double bus bar systems were installed throughout the plant, and three additional 22,000-volt outgoing lines were also provided for.

The new unit was placed in service on February 29th, 1920. Up to this time it is stated that the first two units had been required continuously for operation, but after the new unit was installed one of the two original units was taken out of service, and its turbine and generator completely over-hauled. The installation of the third unit has permitted considerable maintenance work to be done. In addition to overhauling No. 1 unit, Johnson valves were installed on each of the old turbines in place of the old gate valves which it

is stated were very difficult to operate under the high head of this plant.

In constructing the extensions to the plant, the engineers of the Hydro-Electric Power Commission state that provision has been made for one additional 2,820 K.V.A. unit, a third bank of transformers, two more 22,000-volt lines, one additional 4,000-volt feeder and a motor-driven exciter. It is stated that to improve the present operation and to serve the fourth generator and turbine it will be necessary to construct a second pipe line, surge tank and penstock. It is also stated that additional storage amounting to about three hundred million cubic feet is possible by the construction of a dam at Feversham.

At present the Eugenia System consists of three units, two of 1,600 horse-power, and one of 3,200 horse-power, or a nominal total of 6,400 horse-power. A peak load of about 5,500 horse-power has been carried by the plant with one pipe line in 1922. With the second pipe line installed, it is stated in evidence that the present equipment could carry commercial loads up to about 8,000 horse-power, without any spare capacity in machinery. The installation of the fourth unit contemplated would make the total nominal capacity about 9,600 horse-power.

It is understood that the estimated expenditure for 1923 amounts to about $219,000, made up of $50,000 for general improvements, and $169,000 for the second pipe line, surge tank and penstock.

Parallel Operation of Eugenia, Severn and Nasdell's Systems.

A tie line about 24 miles in length between the Eugenia Falls generating

station and the Collingwood distributing station on the Severn System makes possible the parallel operation of the Eugenia Falls generating station, the Big Chute generating station on the Severn System, the Wasdell's Falls generating station on the Wasdell's System, and the Swift Rapids generating station of the Orillia Light and Power Commission. The installation of this tie line has proved of great benefit to the systems concerned. The high head and the large reservoir capacity of the Eugenia Development makes it unusually serviceable as a peak load plant. Off-peak power on the Severn and Wasdell's Systems which could not otherwise be utilized has been, and may be, transferred to the Eugenia System, allowing the Eugenia plant, by operating at a reduced load during the hours of supply from the other systems, to conserve the stored water so as to permit it to be used during peak loads on the combined systems. The transfer of power from one system to another is therefore beneficial to all, and it is understood that book-keeping credits and debits as between the various systems concerned are kept in the books of the Commission. The tie line and the available power from the other systems therefore constitutes an additional source of power for the Eugenia System.

The short distance of the Eugenia System from the Niagara System makes it possible to link the Eugenia System with the Niagara System, if this should prove desirable, by means of short extensions of transmission lines and the installation of frequency changers from 25-cycle to 60-cycles.

Undeveloped Power Sites, Eugenia System.

There are a number of undeveloped power sites in the district comprising

the Eugenia System, but it is understood that the Hydro-Electric Power Commission has no financial interest in any of these at the present time. The following table gives the details of the three most important undeveloped power sites in the district which might be available as future sources of power supply. The details given in the table were furnished by the engineers of the Hydro-Electric Power Commission:

Table of Undeveloped Power Sites

Data	Hayward's Falls Site	Port Elgin Site	Kimberley Site
1. Name of River	Rocky Saugeen	Saugeen	Beaver
2. Drainage area, square miles	107	1,565	100
3. Minimum precipitation per annum, in inches	24.8	24.8	34.2
4. Mean precipitation per annum, in inches	40.0	40.0	37.8
5. Minimum mean monthly run-off, cubic feet per second	54	385	39
6. Mean run-off per annum, cubic feet per second	127	1,940	131
7. Minimum available head, feet	71	100	114
8. Mean available head, feet	71	110	114
9. Years of precipitation records	1883-1900	1883-1900	1916-1921
10. Years of gauging records	1915-1921	1913-1921	1915-1921
11. Water horse-power, mean	1,020	24,000	1,690
12. Water storage, million cubic feet	78	1,500	700

A study of the preceding table shows that the Hayward's Falls site and the

Kimberley site are comparatively small.

The Kimberley site on the Beaver River is a few miles below the Eugenia Falls site, the drainage area being about 100 square miles above this point. The advantage of the Kimberley site is that it could get the benefit of the storage already developed at Eugenia Falls. The head being 114 feet, it is likely that an installation of about one-fifth to one-quarter of that at Eugenia Falls could be made available. It is not likely that more than 2,000 horse-power could be economically installed at this point.

The Hayward's Falls site on the Rocky Saugeen River would probably be of very little commercial value because of the small drainage area of the river, namely 107 square miles, and the comparatively small storage available. It is not likely that it would give more than about 800 or 1,000 horse-power at the most.

Some discussion has taken place regarding a site near the mouth of the Saugeen River known as the Fort Elgin or Southampton site. The ultimate commercial development at this site would depend largely on the amount of storage made available. The minimum monthly run-off is stated to be about 385 cubic feet per second, while the mean run-off per annum is said to be about 1,940 cubic feet per second. It is stated that one billion five hundred million cubic feet of storage could be made available. If the above hydraulic conditions were realized under the stated mean head of 110 feet, it is likely that a power development having a capacity of several thousand horse-power could be economically developed. The total installed capacity would depend largely on the load factor on the system and the storage available. There is not sufficient information available at the present time to give a reasonable

estimate of the ultimate installed capacity. This site is apparently now owned by the Saugeen Electric Light and Power Company, which has a development of about 300 horse-power at the present time, under a low head.

Miscellaneous Power Plants in the District.

There are about fifteen small power plants at various places on the Eugenia System, some of which have been idle since the System took over the supply of energy, and some of which are in service for those places which have not yet joined the Eugenia System. A number of the idle plants can be used locally in case of emergency. The only plant of magnitude is the 1,000 horse-power steam stand-by plant in Owen Sound. The following table gives the location, size, and ownership of the various plants:

Table of Miscellaneous Power Plants in the District of Eugenia System.

Location	Kind of Power	Approximate H. P.	River	Owner and Remarks
Arkona	Water	100	Sauble	Rock Glen Power Co.
Cargill	Water	100	Teeswater	Cargill, Limited.
Hanover	Water	200	Saugeen	Municipal.
Kincardine	Steam	150	-	Municipal.
Lucknow	Steam	75	-	Walter Stewart & Son, (direct current)
Meaford	Water	400	Big Head	Geo.Bay Milling & Power Co., (ultimate capacity said to be about 2,000 H.P.)
Orangeville	Water	330	Credit	Cataract Electric Co., (supplies Erin, Alton & Melville also)

Table of Miscellaneous Power Plants in the District of Eugenia System. (continued)

Location	Kind of Power	Approximate H. P.	River	Owner and Remarks
Orangeville	Steam	150	-	Cataract Electric Co., (stand-by, hardly ever used)
Owen Sound	Steam	1,000	-	Municipal, (stand-by, hardly ever used)
Paisley	Water	100	N. Saugeen	J. McNeil, (133-cycles)
Southampton	Combined	300	Saugeen	Saugeen Elec.Light & Power Co., (supplies Port Elgin also)
Teeswater	Water	50	Teeswater	Teeswater Elec. Light Company, (133-cycles)
Teeswater	Steam	50	-	Teeswater Electric Light Company
Thornbury	Water	75	Beaver	Municipal, (125-cycles)
Walkerton	Water	300	Saugeen	Walkerton Elec. Light & Power Co.
Wiarton	Water	250	Semble	Semble Falls Light & Power Co.
Wingham	Water	200	Maitland	Municipal, (power available 7 or 8 months)
Wingham	Steam	250	Maitland	Municipal.

Transmission Lines.

Up to October 31st, 1921, the Hydro-Electric Power Commission had acquired or constructed a total of 295.7 miles of high tension transmission lines forming a 22,000-volt network supplying the various municipalities. A few districts are supplied by means of 4,000-volt lines, either from the Eugenia Falls generating station or from some of the individual transformer stations.

The transmission system is constructed on wooden poles throughout and presents no extraordinary features. Extensions estimated to cost about

$260,000 for 1922 and 1923 are said to be contemplated, this figure including an allowance for the conversion of power from the Niagara System at 25-cycles for use on the Eugenia System at 60-cycles, and for a large extension in the rural lines.

Transforming and Distributing Stations.

The transmission lines feed the various municipalities at low voltage through eighteen substations, which are listed in the following table, showing their voltage and capacity. It will be noted that only two or three of these stations are of noticeable magnitude, namely Owen Sound, 1,650 K.V.A., and Hanover, 2,250 K.V.A., the latter feeding several other places.

Table of Transforming and Distributing Stations.

Location	Capacity K.V.A.	Voltage H.T.	Voltage L.T.	Remarks
Owen Sound	1,650	22,000	2,300	
Kilsyth	75	"	2,300/575	Supplies Tara at 4000 volts.
Chatsworth	75	"	2,300	
Dundalk	75	"	2,300	
Shelburne	150	"	2,200	Supplies Horning's Mills at 4000 volts.
Orangeville	300	"	2,300/550	Supplies Alton at 4000 volts.
Grand Valley	225	"	2,300/575	Supplies Arthur at 4000 "
Priceville	20	"	2,200	
Durham	300	"	2,300	Supplies Holstein.
Mount Forest	300	"	2,300	
Hanover	2,250	"	2,300/575	
Elmwood	50	"	2,300/575	
Chesley	300	"	2,300	
Walkerton Stone Quarry	450	"	2,200	
Teeswater	150	"	2,200	
Wingham	750	"	2,200/575	
Holyrood	300	"	2,200	Supplies Ripley & Lucknow.
Kincardine	375	"	2,300/575	
Total	7,795			

Note: The transformer banks in the preceding table are arranged to be connected in star on the H. T. side to give 4,000 volts for distribution.

Local Distributing Systems.

With the exception of the rural lines already mentioned and sundry customers at Horning's Mills there are no municipalities on the Eugenia System in which the Hydro-Electric Power Commission distributes retail power to the consumers. The Commission acts as a wholesale distributor and in all the municipalities the electricity is distributed by the municipality itself or by local commissions in the municipalities. It is understood that the accounting for all of the municipalities of the Eugenia System is done in accordance with the standard accounting system of the Hydro-Electric Power Commission, and the details for the various municipalities are given in the Annual Reports.

Characteristics of Market.

Population Served and Percentage of Consumers to Population.

The district served by the Eugenia System is both urban and rural, the bulk of the load being in the various municipalities, most of which are small.

The combined population of the municipalities served by the Eugenia System is approximately 40,000 persons.

The table on the following page gives in detail the number of consumers

at the end of the fiscal year 1921 in the places served by the Commission, the approximate horse-power billed to each place in 1921, the kilowatt hours consumed for the System in 1921, and the average horse-power per consumer for 1921. The figures are useful for comparison with other systems, although they should be used with caution.

Table of Market Statistics

Municipality	Population 1921	Consumers 1921	Percentage Consumers to Population	H.P. Billed 1921	Kilowatt Hours 1921	Billed H.P. per Consumer	Kilowatt Hours per Consumer
Arthur	1218	177	14.5	134.2		.758	
Chatsworth	326	80	24.5	28.5		.356	
Chesley	1721	373	21.7	241.6		.647	
Dundalk	690	186	26.9	97.7		.526	
Durham	1400	347	24.8	220.5		.635	
Elmwood	-	56	-	54.5		.970	
Flesherton	417	123	29.5	47.1		.383	
Grand Valley	595	153	25.7	62.9		.412	
Hanover	2842	591	20.8	1040.7		1.760	
Holstein	--	46	-	9.5		.207	
Kincardine	2036	409	20.1	58.0		.142	
Lucknow	918	158	17.2	39.3		.249	
Markdale	927	233	25.1	85.2		.366	
Mount Forest	1825	377	20.6	185.6		.493	
Neustadt	444	88	19.8	126.3		1.437	
Orangeville	2427	326	13.4	142.1		.436	
Owen Sound	12013	2653	22.1	1391.2		.525	
Priceville	-	24	-	4.1		.171	
Ripley	-	98	-	38.7		.395	
Shelburne	1075	293	27.2	178.4		.610	
Tara	537	126	23.5	41.2		.327	
Teeswater	807	165	20.4	60.4		.366	
Wingham	2387	521	22.3	284.4		.546	
Total	54,555	7,603	22.0	4,571.6	18,932,600	.601	1,832

In the annual reports of the Hydro-Electric Power Commission the letters

P. V. appear in place of population in the case of a number of the smaller municipalities. In compiling the figures in the annual report for total population a round figure of 500 is added for each of these places. This number has been included in this report as the population of each of these places in obtaining the average kilowatt hours billed per capita for 1921.

The average horse-power billed per consumer and per capita, and the average kilowatt hours per consumer and per capita, are as follows:

Average H.P. Billed per Consumer, 1921	0.601
Average H.P. Billed per Capita, 1921	0.132
Average K.W.H. Billed per Consumer, 1921	1,832
Average K.W.H. Billed per Capita, 1921	403

Growth of Market and Ultimate Sources of Power Supply.

Since the commencement of operations in 1915, the growth of the System has been fairly steady. The loads on the System were as follows, the figures being given in horse-power for the month of October in each year:- 1916, 1,598; 1917, 1,770; 1918, 3,179; 1919, 4,350; 1920, 5,644; 1921, 5,520.

These figures do not indicate the actual peak demands of the system, but they do show the growth of the demand. Owing to the inter-connection of the Wasdell's, Severn and Eugenia Systems, and the methods of keeping the records by the Hydro-Electric Power Commission of Ontario, it is impracticable to separate the records satisfactorily so as to indicate the actual peak on any one part of the combined Northern Systems. Briefly, it may be noted that in 1921 the total loads billed to the municipalities is nearly four times as great as it was in 1915 and 1916.

The ratio of consumers to population at the end of 1921 was 32.0 per cent, which compares well with other systems. The general growth in the load and in the number of consumers has been comparatively steady, making due allowance for the abnormal conditions following the armistice in November 1918, and the indications are that the demands are still increasing.

The situation at the present time is that the Eugenia System now requires practically the whole of the installed capacity of the Eugenia Falls plant for peak operation, together with a certain amount of power supplied from the adjacent systems. For the past three years practically no power has been transmitted to the Severn System from the Eugenia plant. The indications are that additional power will be required in the near future. Careful consideration should be given to the question of installing the second pipe line and also an additional unit and continuing to operate this plant for peak loads, taking full advantage of the present storage and possibly adding additional storage by the construction of the proposed dam at Feversham. The operation of the plant with the additional unit installed and the additional storage developed would probably be at a different daily plant factor than that obtaining at the present time, and if manufacturing increases in the Eugenia district it is likely that base or primary power may have to be supplied from the Severn System or elsewhere to carry the manufacturing loads. On the other hand, if the further development of the district demands more lighting than power the Eugenia Falls plant might be able to carry the loads without very much other assistance for some time to come.

This brings up the question of the ultimate use of power in the district and of the future altimate source of power supply. From the table of existing

power plants in the district, as shown on page 16, it will be seen that there are no developed powers of magnitude which would be available, except possibly 2,000 horse-power at Meaford, in the future. Indeed, most of the plants could only be used in emergency for the various localities in which they are found. The steam plant in Owen Sound is the only one which might be counted upon to transmit some power, and then only if the city were receiving a normal supply of hydro-electric energy. The capacity of this plant is not sufficient to supply all the needs of Owen Sound if the city were receiving no hydro-electric energy.

The information regarding the three sites already discussed under the heading of "Undeveloped Power Sites" is meagre, and so far as is known there are no estimates for the construction costs, or for the acquisition of these sites. At the most it is likely that they might only be counted upon for a few thousand horse-power, and judging by a general knowledge of the district the costs would likely be high.

There are comparatively few sites on the Severn, Wasdell's and Muskoka Systems, and it is stated by the engineers of the Hydro-Electric Power Commission that all of the available power in these districts will soon be required for local use. If this be the case there are apparently only two possible sources of supply for any large amounts of power for this district, namely the French River power sites and Niagara power.

If Niagara power be used it would necessitate the building northwards of a number of short tie-lines, for example from Goderich on the Niagara System to Wingham on the Eugenia System, and between other points to the eastwards

where the various northerly branches of the Niagara System approach the southerly ends of the lines of the Severn and Wasdell's System. Niagara Power being generated and transmitted at 25-cycles, the use of this power for the combined Northern Systems would necessitate the installation of frequency-changing apparatus.

To use power from the French River for the Muskoka System and for the combined Northern Systems, and possibly for the Nipissing Section and for the northerly portion of the Trent Section of the Central Ontario System, long transmission lines from the French River to Nipissing, and from Nipissing to Muskoka, and from Muskoka to Wasdell's and to the Trent System would be required. As all of these systems are operated at 60-cycles, the use of French River power, which is contemplated at 60-cycles, would avoid the use of frequency-changing apparatus. The development of the French River sites would depend on the growth of the load in the combined Northern Systems, and in the North Bay-to-Sudbury district to a sufficient degree to permit of their economical use. If the general power demand continues to increase at a rapid rate the total economical capacity of the French River sites, which is probably about 30,000 horse-power, might be reached within a comparatively few years, in which case Niagara power would be the only feasible source of supply. From an operating point of view it would be preferable to use power generated at 60-cycles and avoid the complication of frequency changers. It is understood that the Hydro-Electric Power Commission contemplates the use of some Niagara power through frequency changers in the near future.

If Niagara power be used it might prove desirable to separate a number of

the municipalities from the present partnership arrangement on the Eugenia System and add those municipalities to the Niagara System, in which case the accounting should take into consideration the re-allocation of the cost of that portion of the System so affected.

On the other hand, if power be transmitted from the French River, a system of billing for each of the four or five Systems affected would have to be developed so as to fairly apportion the cost of the transmitted power.

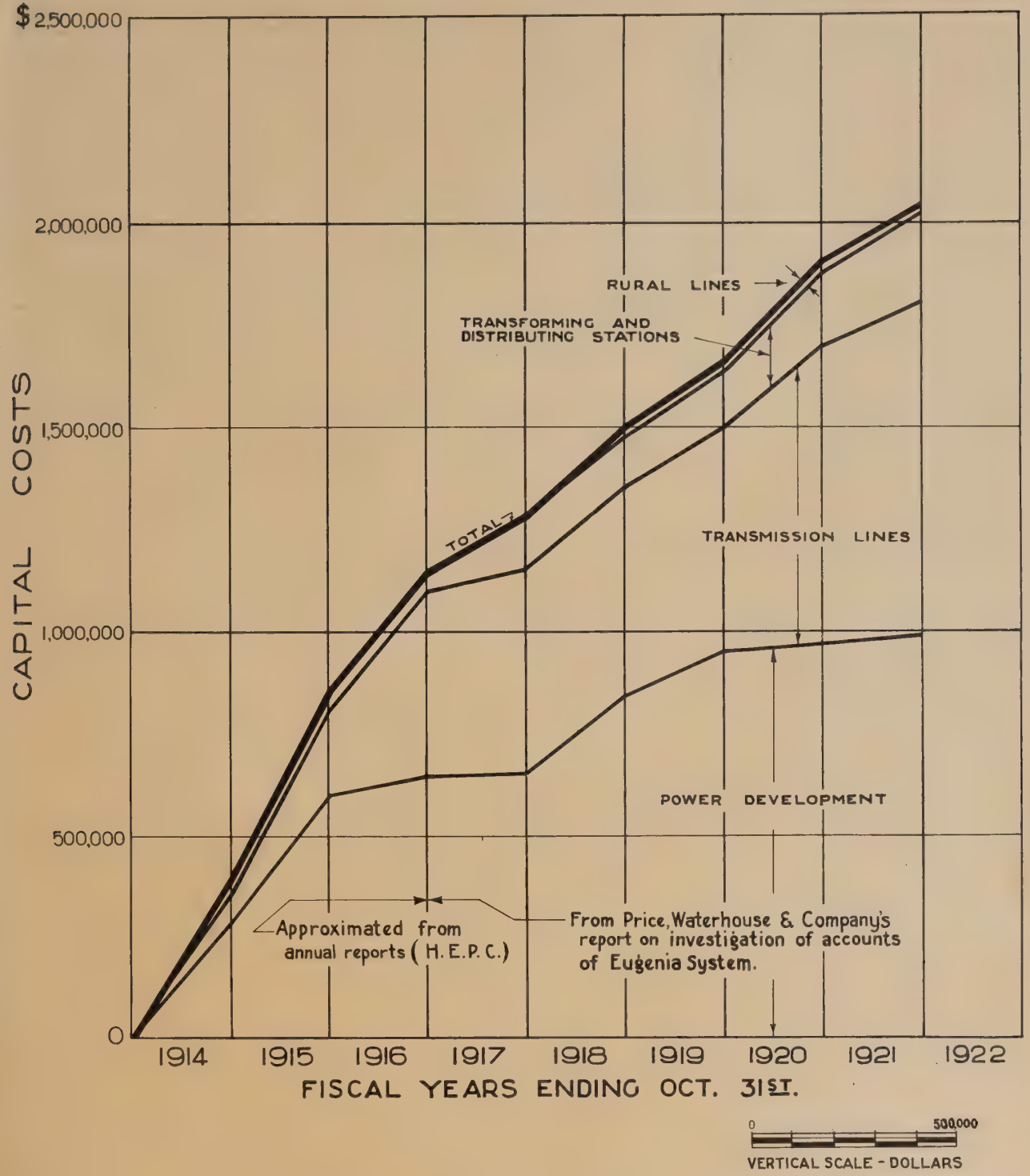
Capital Costs.

General.

The figures of capital costs given in the table below and plotted diagrammatically, and shown on the sheet of curves on page 26, were obtained from page 6 of the report of Messrs. Price, Waterhouse & Co. to the Hydro-Electric Inquiry Commission under date of November 29th, 1922, except for the years 1914 to 1916 inclusive, which were obtained from the Annual Reports of the Hydro-Electric Power Commission:-

Table of Progressive Capital Costs

Capital Assets	As at Year Ending October 31st, 1914	1915	1916	1917
Power Development	$228,856	$599,935	$650,974	$658,353
Transmission Lines	10,103	242,800	446,632	502,659
Transforming and Distributing Stations	80	16,608	53,194	115,264
Rural Lines	-	-	-	-
Total	$238,739	$859,343	$1,149,800	$1,276,276



HYDRO-ELECTRIC INQUIRY COMMISSION
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ECONOMICS OF H.E.P.C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM
PROGRESSIVE CAPITAL COSTS

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Table of Progressive Capital Costs, (continued)

Capital Assets	As at Year Ending October 31st, 1918	1919	1920	1921
Power Development	$840,140	$956,769	$979,425	$990,438
Transmission Lines	518,068	544,059	727,460	815,629
Transforming and Distributing Stations	143,048	161,995	206,880	240,501
Rural Lines	1,576	1,695	1,695	2,095
Total	$1,502,832	$1,664,518	$1,915,460	$2,048,663

It will be noted that the total capital costs to the end of 1921, amounting to approximately two million dollars, is divisible roughly into one million dollars for the plant at Eugenia Falls, eight hundred thousand dollars for transmission lines, and about a quarter of a million dollars for transforming and distributing stations.

The sub-divided costs of the Eugenia Falls plant are as follows; land and water rights, $127,284; dams and water structures, $439,790; power house, $144,783; equipment, $278,416; total $990,273. Nothing is included for intangibles.

Power Data

The table on the following page and the diagram on page 29, have been prepared to show the characteristics of the Eugenia System in terms of horsepower:

COPY

Table of Horse-power Developed, Consumed, Billed, Etc.

	Fiscal Year Ending October 31st,					
	1915--17	1918	1919	1920	1921	1922
H. P. Developed	3,200	3,200	3,200	6,400	6,400	6,400
H. P. Consumed, Average	-	-	-	-	2,132	2,680
Total H. P. Billed	-	4,091.4	4,350.2	3,355.1	4,698.5	5,183.3
H. P. Billed to Eugenia System	-	2,754.4	3,303.2	3,337.7	4,652.7	5,183.3
H. P. Billed to Severn System	-	1,337.0	1,047.0	17.4	45.8	0

It will be noted that there are five different classes of horse-power shown on the table and in the diagram. These may be explained as follows:

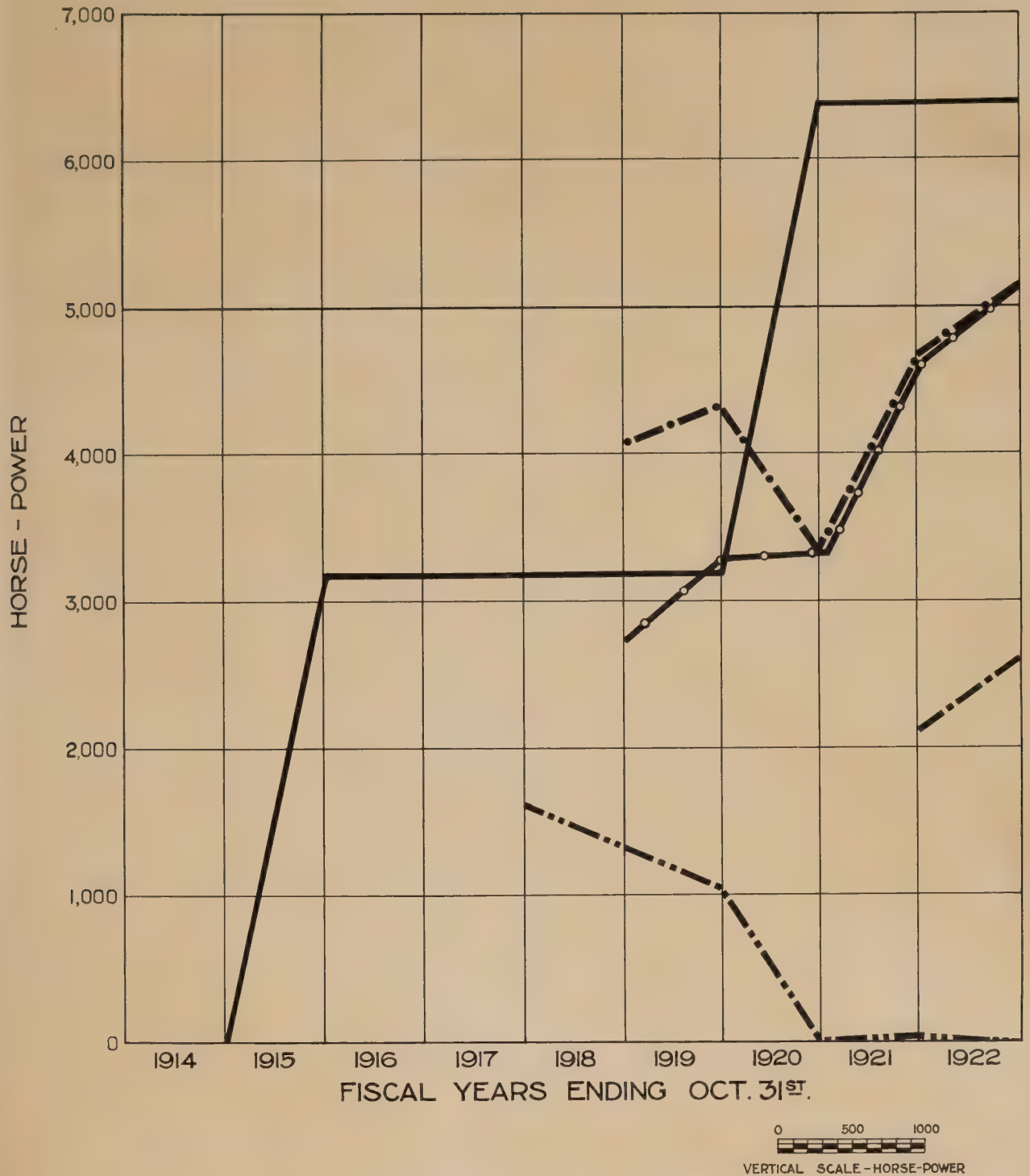
Developed Horse-power.

The figures for plotting the curves showing the developed horse-power were obtained from the records of the Hydro-Electric Power Commission and are the sum of the capacities of the various units installed in the Eugenia Falls station expressed in horse-power at the usual Hydro-Electric Power Commission rating.

No curve has been plotted showing developed plus purchasable power because up to the end of 1921 the Eugenia System had supplied more power to the Severn System than it had received.

Average Horse-power Consumed.

The average horse-power consumed has been derived from the total number of kilowatt hours given by the Hydro-Electric Power Commission as being the total



DEVELOPED H. P.
TOTAL H. P. BILLED PER ANNUM
H. P. BILLED PER ANNUM TO SEVERN SYSTEM
H. P. " " " " EUGENIA "
AVERAGE H. P. CONSUMED PER ANNUM

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EUGENIA SYSTEM

HORSE-POWER DATA

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kilowatt hours supplied to the Eugenia System for the years ending October 31st, 1921 and 1922. The derivation was made by dividing the total kilowatt hours per annum by 8,760, being the number of hours in a year, and reducing to horse-power by dividing by the factor, 0.746.

Billed Horse-power.

The curve of billed horse-power was plotted from data given in the report of Price, Waterhouse & Co. on the "Investigation of the Accounts of the Eugenia System", dated November 29th, 1922, Exhibit LA, Hydro-Electric Inquiry Commission file 228-a-2, dated December 11th, 1922.

A subdivision has been made between the horse-power consumed by the Eugenia System and that delivered from the Eugenia to the Severn System.

A study of these three curves shows the reason for the dip in the curve of total horse-power billed in 1920. The general falling-off in power demand at that time was accentuated on the Eugenia System due to the fact that as the demand on the Severn System decreased all of that decrease was passed over to the Eugenia System. The demand from the Eugenia System itself does not show any actual drop, and after remaining almost constant for a year it began to increase rapidly during 1921, and is still increasing.

Some further information regarding the supply of power from the Eugenia System to the Severn System is given on page 14 of the Price, Waterhouse & Co. report already mentioned, and in this connection it is also interesting

to note the remarks on page 11 of the same report regarding the contract with the National Portland Cement Company of Durham.

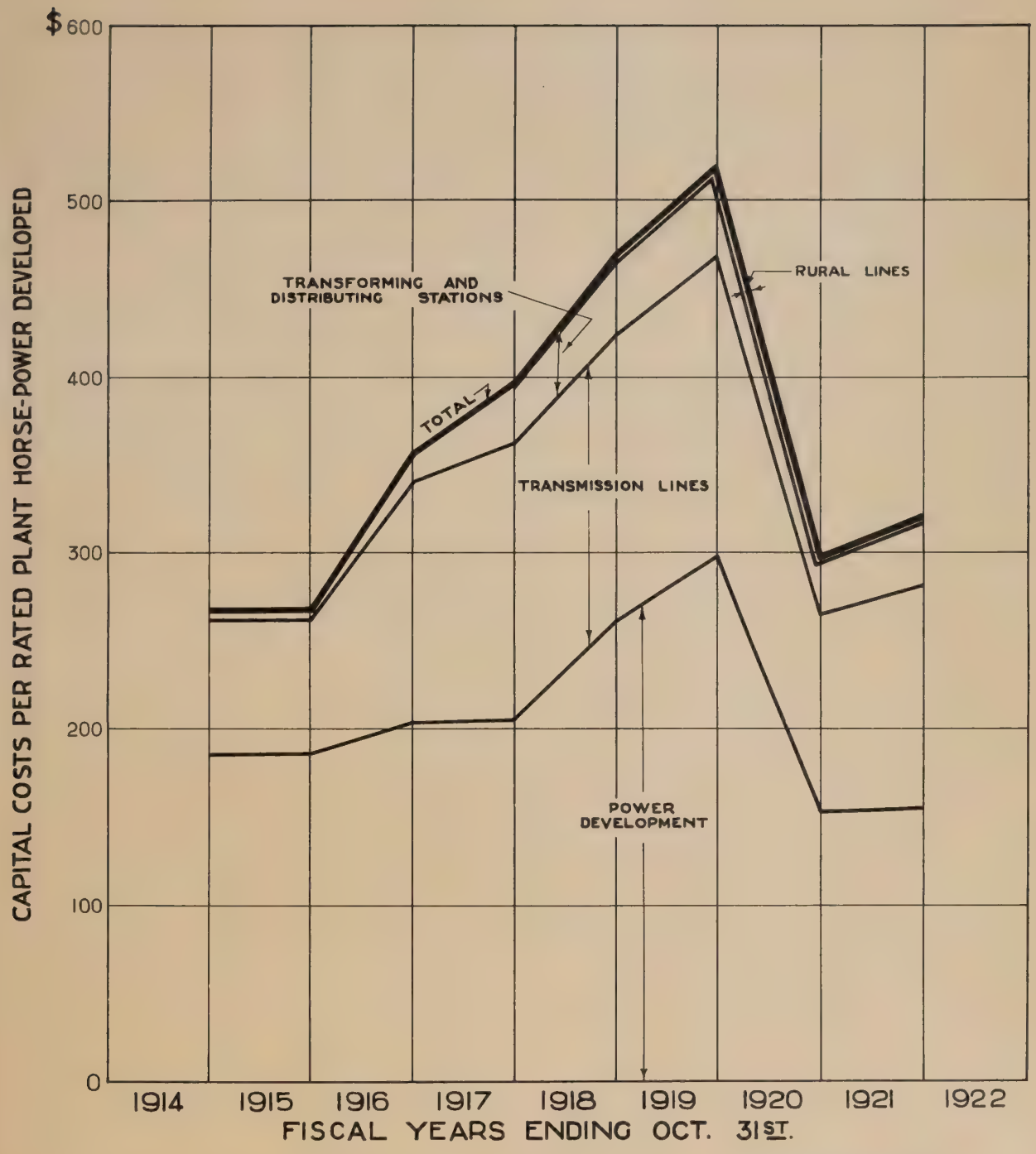
Capital Costs per Horse-power Developed.

The diagram included as page 32 and the table below indicate the fractional capital costs per rated plant horse-power developed at different points of delivery, based on the figures showing the capital costs of the system, and the horse-power data given above. This sheet of curves, therefore, indicates the capital costs per rated plant horse-power with the spaces between adjacent curves indicating that portion of the total (delivered) capital cost per horse-power chargeable against each of the items of the table, as follows:

Table of Capital Costs per Rated Plant Horse-power Developed.

	1915	1916	1917	1918	1919	1920	1921
Power Development	$187.40	$203.00	$205.70	$262.52	$299.00	$153.01	$154.70
Transmission Lines	76.00	139.20	157.00	161.92	170.00	113.71	127.50
Transforming and Distributing Stations ...	5.20	16.60	36.20	44.70	50.49	32.31	37.60
Rural Lines	-	-	-	0.49	0.53	0.26	0.33
Total ...	$268.60	$358.80	$398.90	$469.63	$520.02	$299.29	$320.13

The large rise in the unit costs in 1918 and 1919 is due to large capital expenditures being made for which no additional power was made available until



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EUGENIA SYSTEM

CAPITAL COSTS PER H.P. DEVELOPED

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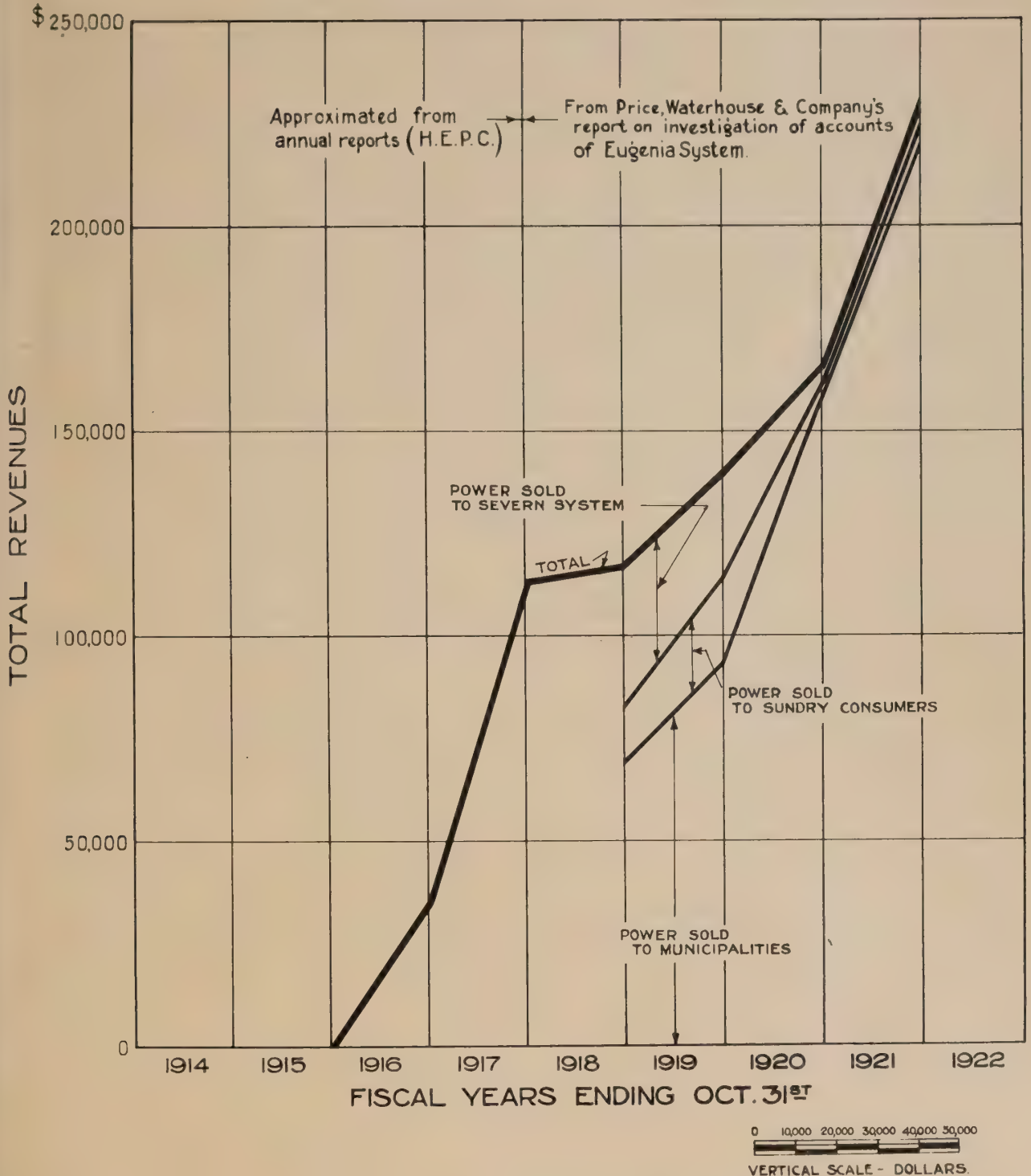
1920, when the new unit at Eugenia Falls came into service with a consequent drop in the unit costs.

Total Revenues.

The table on page 35, giving the total revenues of the Eugenia System has been prepared by using the figures of Exhibit I, supplemented from page 8 of the report on "Investigation of Accounts of Eugenia System" dated November 29th, 1922, Hydro-Electric Inquiry Commission file No. 223-a-2. This applies to the years 1916-1921 inclusive. The sheet of curves on page 34 shows the revenues in graphic form.

From this information it may be deduced that the municipalities were charged with the cost of power and the distribution thereof and with that portion of the fixed charges which pertained to the power supply. They obtained certain reductions in cost over the whole period by crediting to themselves the profit arising from the sale of power to the Severn System. The power sold to sundry customers was charged with its proportion of operating expenses and fixed charges, and whatever profit or loss was realized or incurred, was (except for the year 1921) transferred to the Reserve for Contingencies. The figures for the revenues in the years 1916 and 1917 were taken from the Annual Reports of the Hydro-Electric Power Commission. The table of revenues is as follows:



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EUGENIA SYSTEM

TOTAL ANNUAL REVENUES

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Table of Total Revenues for Various Classes of Customers

	1916	1917	1918	1919	1920	1921
Power Sold to Municipalities			$68,760	$93,317	$160,198	$221,833
Power Sold to Sundry Customers			13,846	20,878	6,149	4,069
Power Sold to Severn System			34,541	26,961	436	6,418
	$36,670	$113,170	$117,147	$141,156	$166,783	$232,320

Total Costs of Power.

The table on page 38 shows the cost of power subdivided under various headings for the years 1916 to 1921 inclusive. The figures from 1918 to 1921 inclusive are made up from Exhibit I of the Price, Waterhouse & Co. report dated November 29th, 1922, while the figures for the years 1916 and 1917 were obtained from the Annual Reports of the Hydro-Electric Power Commission.

The headings under which the various costs have been grouped are as follows:

Operating Costs.

Operating costs include the wages of power house operators, linemen, station attendants and so forth, power purchased from other sources, supplies and all miscellaneous items usually grouped under this item.

Maintenance.

Under maintenance have been placed all the items for labour and materials charged in the books of the Commission as against the individual portions of the plant, stations, lines and distributing stations, and these have been grouped together, from the individual figures in the Price, Waterhouse & Co. report, to make one item.

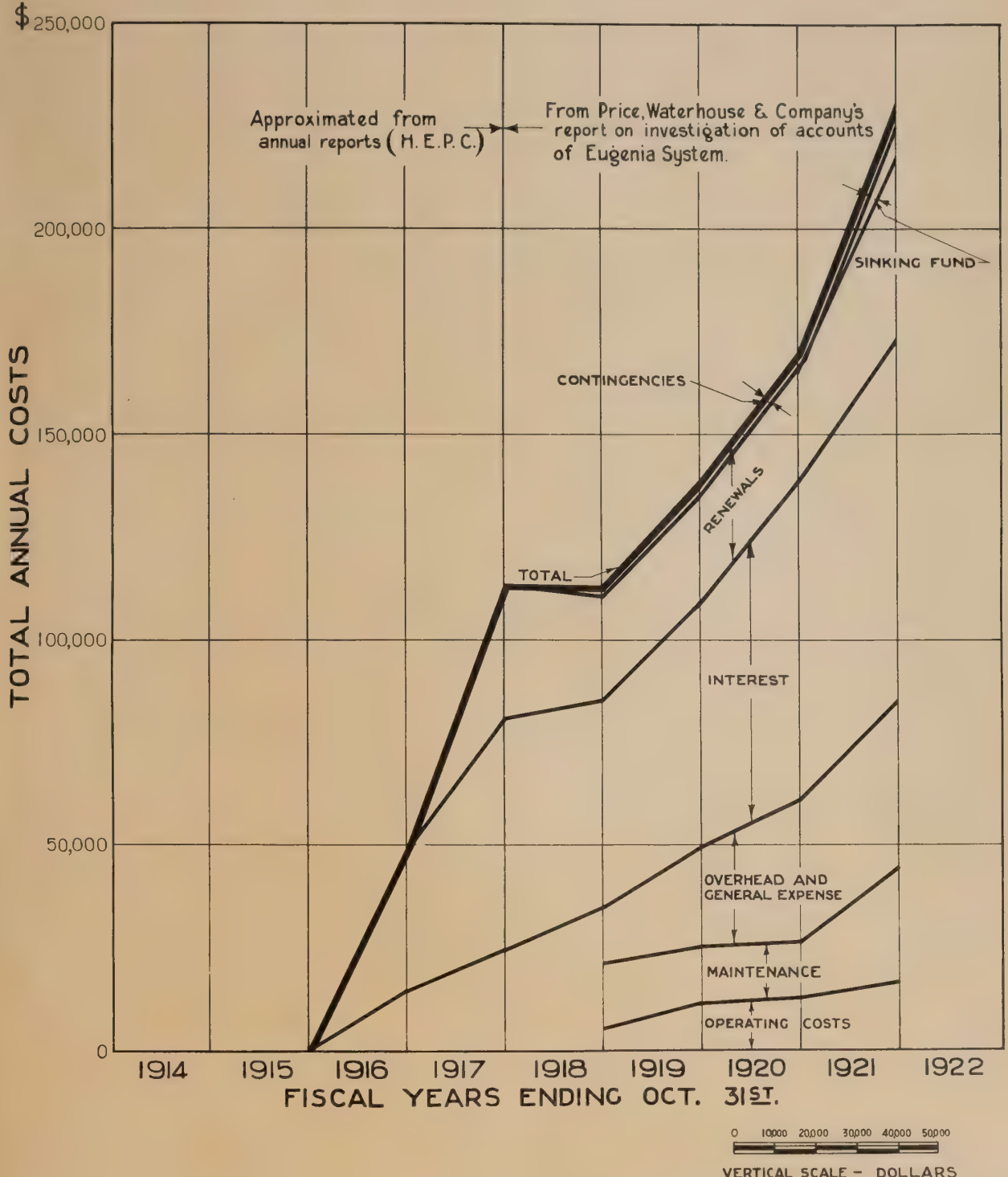
Overhead and General Expense.

Under the heading of overhead and general expense are such items as salaries of local officers and clerks, printing and stationery, stores operation, taxes, insurance, rents, legal expense, miscellaneous office supplies and so forth, all in accordance with the Price, Waterhouse & Co. report, supplemented for the years 1916 and 1917 from the Annual Reports of the Hydro-Electric Power Commission.

Interest, Renewals, Sinking Fund and Contingencies.

The figures for interest include all interest charges shown for the capital invested in the System. The renewal account includes all items shown as chargeable against renewals in the same report, while the figures for sinking fund and for contingencies have been transferred directly from the report.

The sheet of curves on page 37 is the direct plotting of the figures in the



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EUGENIA SYSTEM

TOTAL ANNUAL COSTS

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table below, with the spaces between adjacent curves indicating the amount chargeable against that particular item. The figures are as follows:

Table of Total Yearly Costs of Power

	1916	1917	1918	1919	1920	1921
Operating Costs			$ 5,909	$11,279	$13,150	$16,824
Maintenance			16,405	14,833	13,809	26,974
Overhead and General Expenses	$14,584	$ 26,473	12,286	24,092	35,221	41,801
Interest	34,206	55,762	50,793	59,366	76,885	88,087
Renewals	-	31,935	26,121	28,746	29,972	44,302
Sinking Fund	-	-	-	-	-	13,157
Contingencies	-	-	1,023	1,088	839	1,175
	$ 48,790	$114,170	$112,537	$139,404	$169,876	$232,320

It will be noted that in 1918, 1919 and 1920 there are small differences between the total revenues and the total costs of power, amounting respectively to profits of $4,610, and $1,752 in 1918 and 1919, and a loss of $3,093 in 1920. It is explained that these net differences have been transferred to the reserve for contingencies as a whole, thus making the total revenues and the total costs of power balance in each year.

Percentage Costs of Power.

The following table and sheet of curves included as page 40 show the cost figures as percentages of the total cost of power per annum, and these are included as a method of comparision with other systems or similar properties:

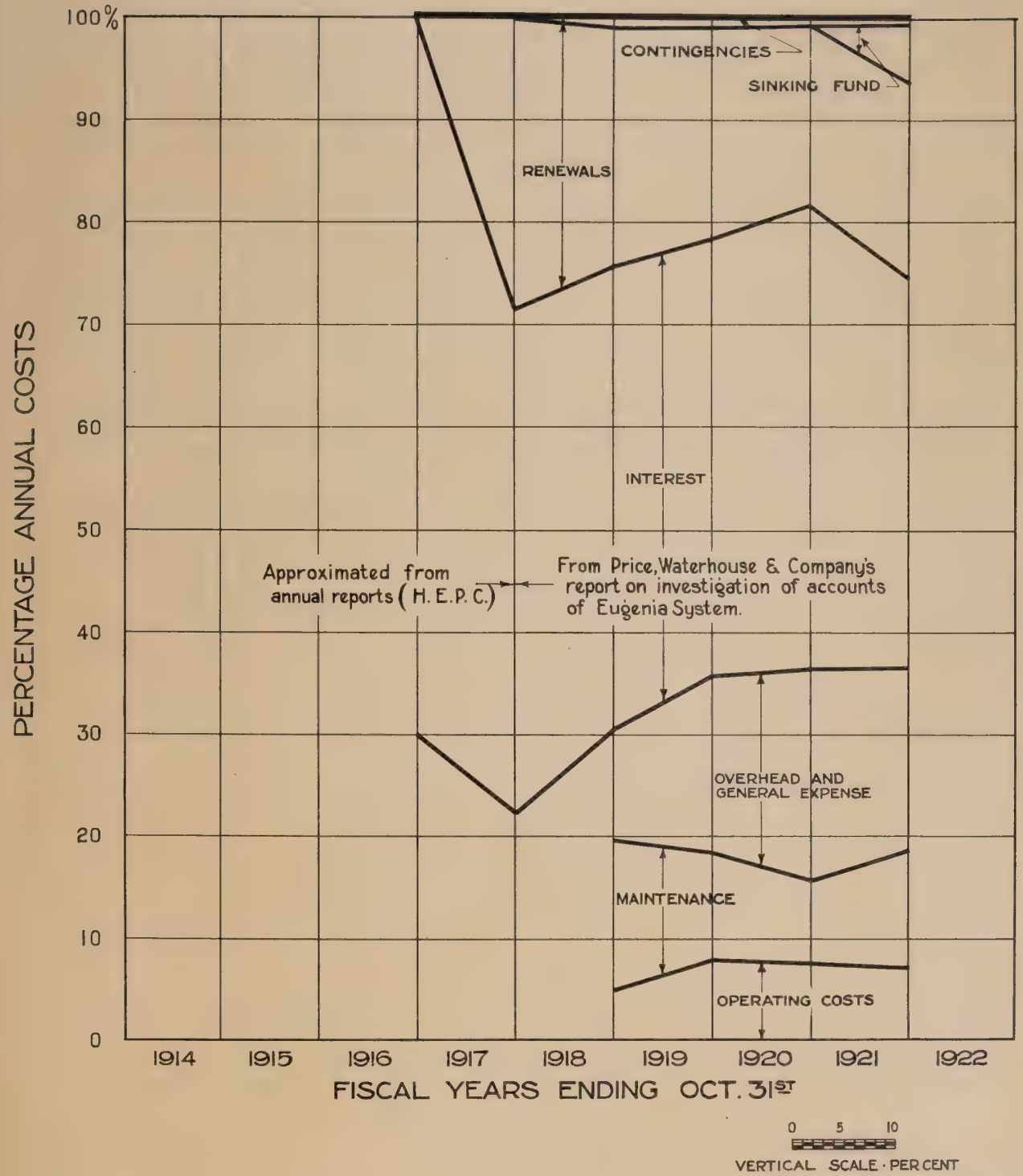
Table of Annual Costs Subdivided by Percentages

	1918	1919	1920	1921
Operation	5.25	8.10	7.75	7.25
Maintenance	14.58	10.65	6.15	11.60
Overhead and General Expense	10.92	17.30	20.75	18.02
Interest	45.13	42.55	45.20	37.90
Reserve for Renewals	23.21	20.62	17.65	19.05
Sinking Fund				5.65
Reserve for Contingencies	.91	.78	.50	.53
Total	100%	100%	100%	100%

Analysis of Reserve Accounts.

Renewals Account.

The table on page 43 and the sheet of curves included as page 44 show the amounts set aside as reserve for renewals as they exist at the present time on the books of the Hydro-Electric Power Commission. As stated on page 16 in the report of Price, Waterhouse & Co., the reserve is based on an annual charge of 2.75% of the depreciable capital investment, together with interest at the rate of 4% per annum on the balance. This follows the usual method, known as the sinking fund basis, for providing a fund for renewals for plant deteriorating in use. The useful life in years of each portion of the depreciable capital invested, the replacement cost, and the residual or scrap value of the articles at the end of this time are all estimated, and an amount is set aside which when compounded at an assumed earning rate will retire the total amount



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EUGENIA SYSTEM
ANNUAL COSTS
SUBDIVIDED BY PERCENTAGES

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to be provided for at the end of its own particular useful life. It is understood that it is the practice of the Hydro-Electric Power Commission to spend sufficient money on maintenance account each year so as to keep each and every portion of the System in a condition to operate in accordance with the requirements of economical production, which it is stated is considered to be about seventy-five per cent. as good as its original new condition. This being so, it was considered in this report that the renewal accounts should be studied in connection with and applied to the renewal of only twenty-five per cent. of the capital concerned.

The annual rate of 2.75%, we are advised, is based upon a re-classification of the various properties in connection with the Eugenia System, from which the engineers of the Hydro-Electric Power Commission deducted certain properties of a substantial nature which they considered should have no provision for renewals, for example reinforced concrete dams, floodage, water rights, and so forth. During the past months the engineering department of the Hydro-Electric Power Commission, together with the heads of the various departments, have been carefully studying the question of depreciation rates, and we are advised that they are now considering a further reduction of the renewal allowances, to be made retroactive for a period of years. This would have the effect of building up the reserve fund in future at a slower rate, and of correspondingly reducing the annual cost, and consequently reducing the total annual cost of power.

There are one or two points which should receive careful consideration in dealing with the question of these reserves for renewals. One is the proposed change in the estimated length of useful life of the various portions of the

equipment, which will materially affect the annual allowances, and the other is the question of the proper rate of interest to be chosen in estimating the earning power of the invested reserve funds.

A strict theory of the earning power of the renewal fund would take into consideration not only the method of investing the fund, for example, whether it be used in making extensions and betterments in the system as has actually been done, or invested in separate securities and treated like a trust fund, but also the rate of annual interest, which should be adjusted each year in accordance with the actual value of money. The legal limitations of the allowable investment of the fund should also be kept in mind in this connection.

At the present time the total depreciable capital is probably in the neighborhood of one and one-half millions of dollars, while the reserve fund amounts to about one hundred and eighty-two thousand dollars. As a large portion of the total depreciable capital has been invested within the past three or four years, and as the useful life of each portion of the equipment is really in its infancy, it would therefore appear that the present total accumulations of the fund as applicable to 25% of the total depreciable capital, is somewhat larger than is necessary, taking all the above factors into consideration. The reserve for renewals on the basis of 2.75% is as follows:

Table of Reserve for Renewals

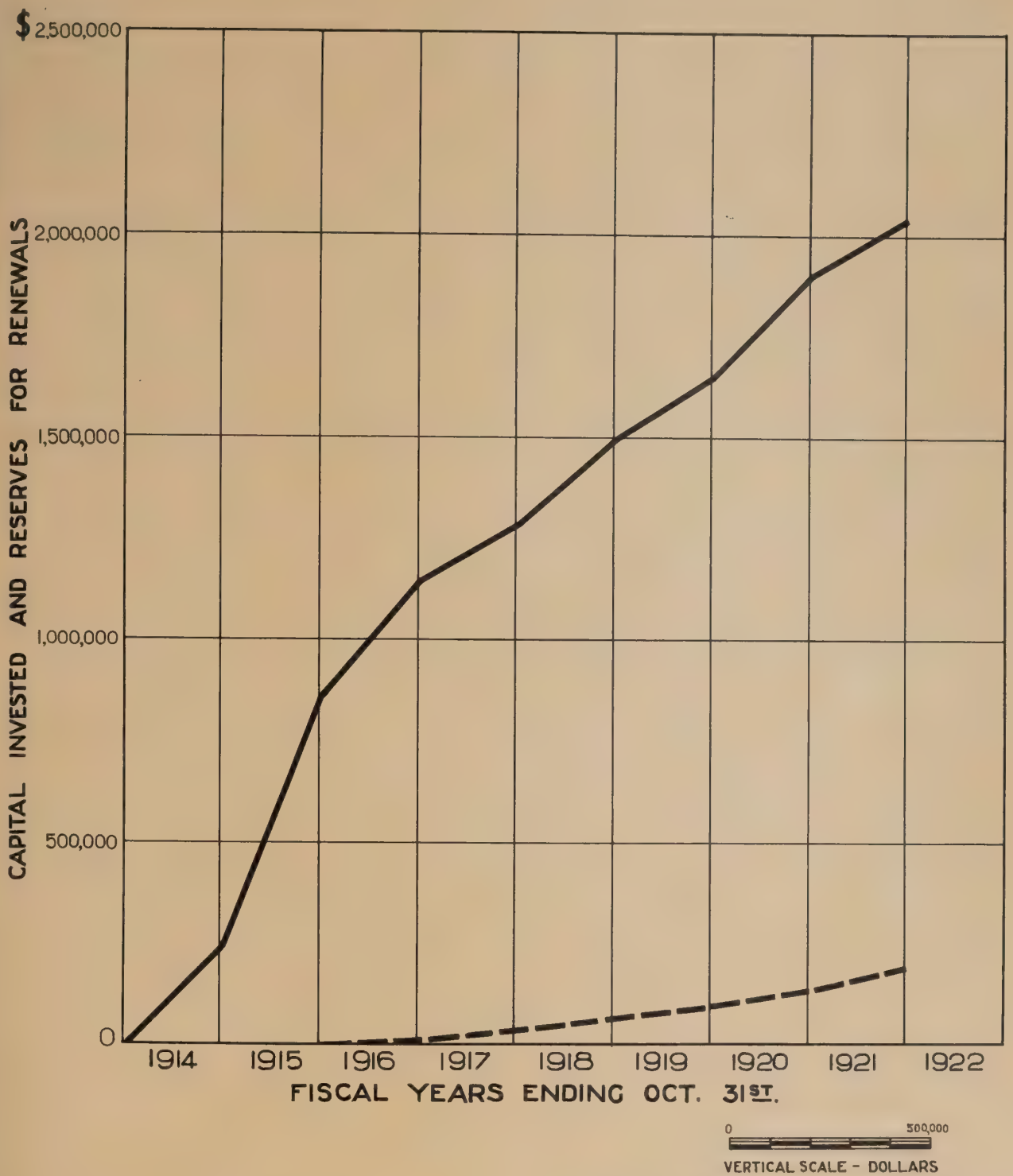
Year Ending October 31st	Reserve	Interest	Together
1916	$ 14,571	-	$14,571
1917	23,044	$ 583	23,627
1918	26,121	1,528	27,649
1919	28,746	2,634	31,380
1920	29,972	3,889	33,861
1921	44,902	5,243	49,545
Together	$166,756	$13,877	$180,633
Miscellaneous additions less deductions			1,197
Total at October 31st, 1921			$181,830

Sinking fund.

The study of the finances of the System shows that a comparatively small amount has been set aside as sinking fund to provide for the financial obligations concerning the properties. The total amount at the end of 1921 was $13,156 for the main system, and about $145 for the rural lines.

At the end of 1921 there were twenty-three municipalities receiving electrical energy, and of these only six had been connected to the system for five years or longer. In accordance with the provisions of the Power Commission Act only these six municipalities have been charged with sinking fund costs, and the Severn System has also been so charged. The sinking fund reserves for the rural lines have been paid by the municipalities of Markdale and Fleshorton.

Apparently the sinking fund provision is being made in accordance with



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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM

RESERVES FOR RENEWALS

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the requirements of the Act.

Reserve for Contingencies.

A study of the accounts of the System shows that up to the end of 1921 a total reserve for contingencies has been set aside amounting to $20,485 made up of an annual charge of 25 cents per horse-power on the average power billed to the municipalities and to the Severn System and to sundry customers, and of certain profits realised on sales to sundry customers, together with the profit from the sales of miscellaneous equipment, and an allowance for interest at 4% per annum. From this sum has been deducted about $8,385.00 for uncollectable bills, storm damage to lines, dismantling the National Cement Company's station and miscellaneous items.

Having in mind the heavy losses which might be occasioned through catastrophe, it is felt that the total amount at the credit of this fund, namely about $13,000, should be augmented by increasing the annual allowance for contingencies, and when a reserve of, say, $25,000 or $30,000 will have been built up the rates can be re-adjusted to suit the conditions found after several further years of experience.

Discussion of Deficits and Surpluses.

The records show that the System as a whole has been billed with the cost of power in accordance with the book-keeping methods of the Hydro-

Electric Power Commission since 1918, and that there are now no deficits or surpluses for the System as a whole. This does not take into account the local distribution in the various municipalities, which is done by the municipality itself or by a separate commission in such municipality and where the profits or losses are not included in the accounts of the Hydro-Electric Power Commission for the Eugenia System.

Revenues and Costs per Horse-power per Annum.

In order to reduce the total revenues and total costs of operation to a basis where these would be comparable with other systems and to agree with the usual practice of similar companies and of distribution authorities, a set of diagrams has been prepared to show the revenues per horse-power per annum from different main groups or classifications of consumers and to show the revenue per horse-power per annum for different bases of horse-power.

In a similar manner, the total costs have been reduced to costs per horse-power per annum for different bases of horse-power and have also been analyzed to show the total annual costs subdivided into fractional amounts chargeable against each kind of expense based on the horse-power rating of the plant and also on the average horse-power billed.

The following series of diagrams, with the table of figures for each, show these various items in detail.

The various revenues for each classification of horse-power are given in the following table and on the sheet of curves on page 48 hereof.

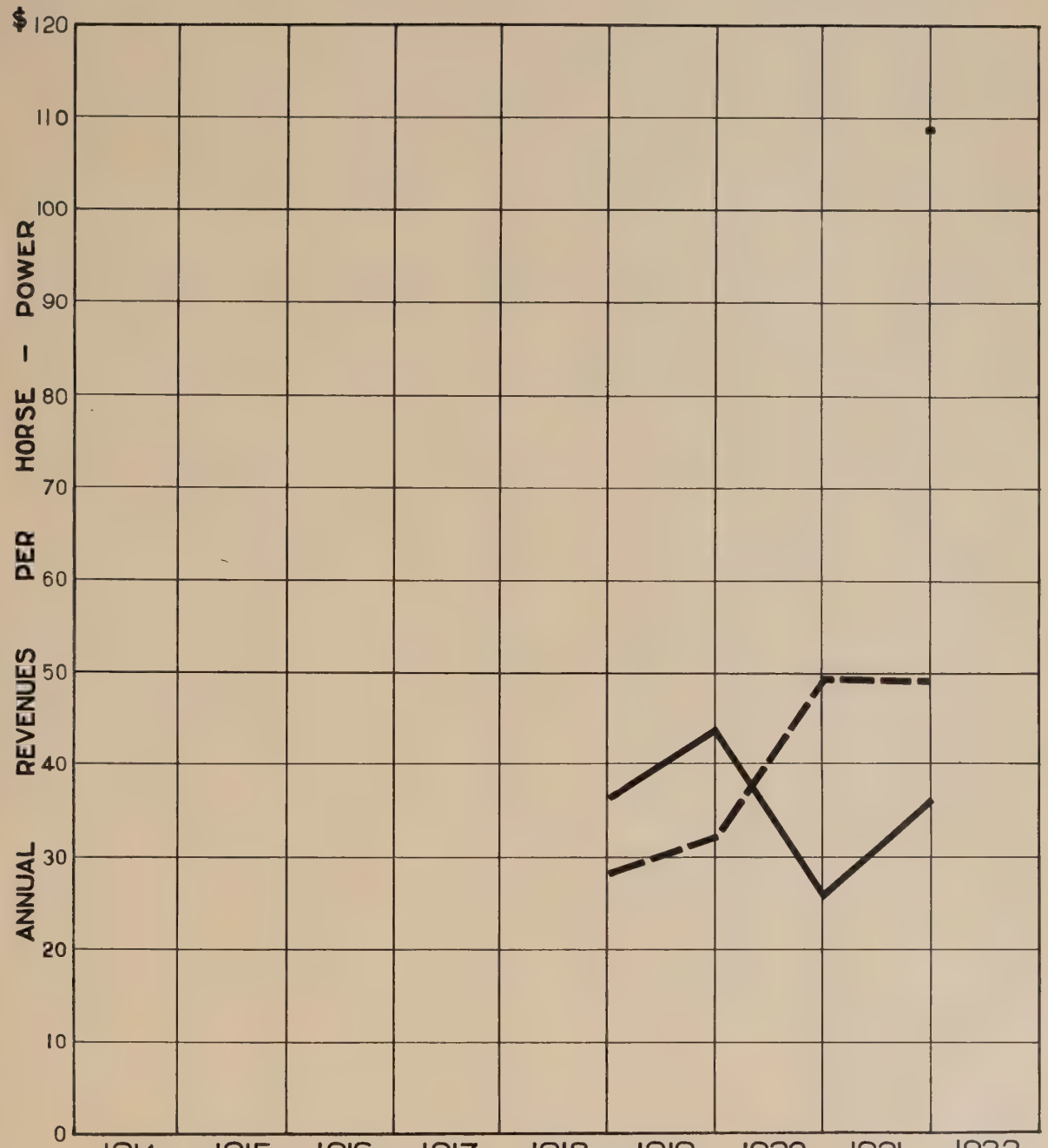
Table of Revenues per Horse-power per Annum

Revenues per Horse-power	1918	1919	1920	1921
Developed	$36.61	$44.11	$26.06	$36.30
Consumed	-	-	-	108.97
Billed	29.63	32.45	49.71	49.45

Annual Costs per Horse-power.

The three sheets of curves on pages 50, 51 and 52 and the tables on page 49 show the details of the costs per horse-power per annum on different bases. The figures from which the curves were plotted are the figures for the operating costs given in the table on page 38 divided by the figures for the various classes of horse-power already given in the text. The sheet of curves included as page 50 indicates the total costs per horse-power per annum for the different classifications of horse-power already discussed. It will be noted that the total costs per horse-power per annum do not balance with the total revenues per horse-power per annum for the reasons given on page 38 of this report.

The sheet of curves on page 51 entitled "Subdivided Costs per Horse-power for Power Developed", indicates the subdivision of the total annual costs as between operating, maintenance, overhead and general expense, interest, renewals, sinking fund and contingencies divided by the total amount of horse-power developed in the Eugenia Falls plant. Similarly, the sheet of curves on page 52 indicates the subdivided costs for the horse-power billed.



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VERTICAL SCALE - DOLLARS

REVENUE PER H.P. CONSUMED ▪
REVENUE " " " BILLED ——————
REVENUE " " " DEVELOPED ——————

HYDRO-ELECTRIC INQUIRY COMMISSION
W. D. GREGORY, CHAIRMAN

ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM

REVENUES PER H.P. PER ANNUM.

VARIOUS H.P. BASES

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CONSULTING ENGINEERS

Table of Total Costs per Horse-power per Annum

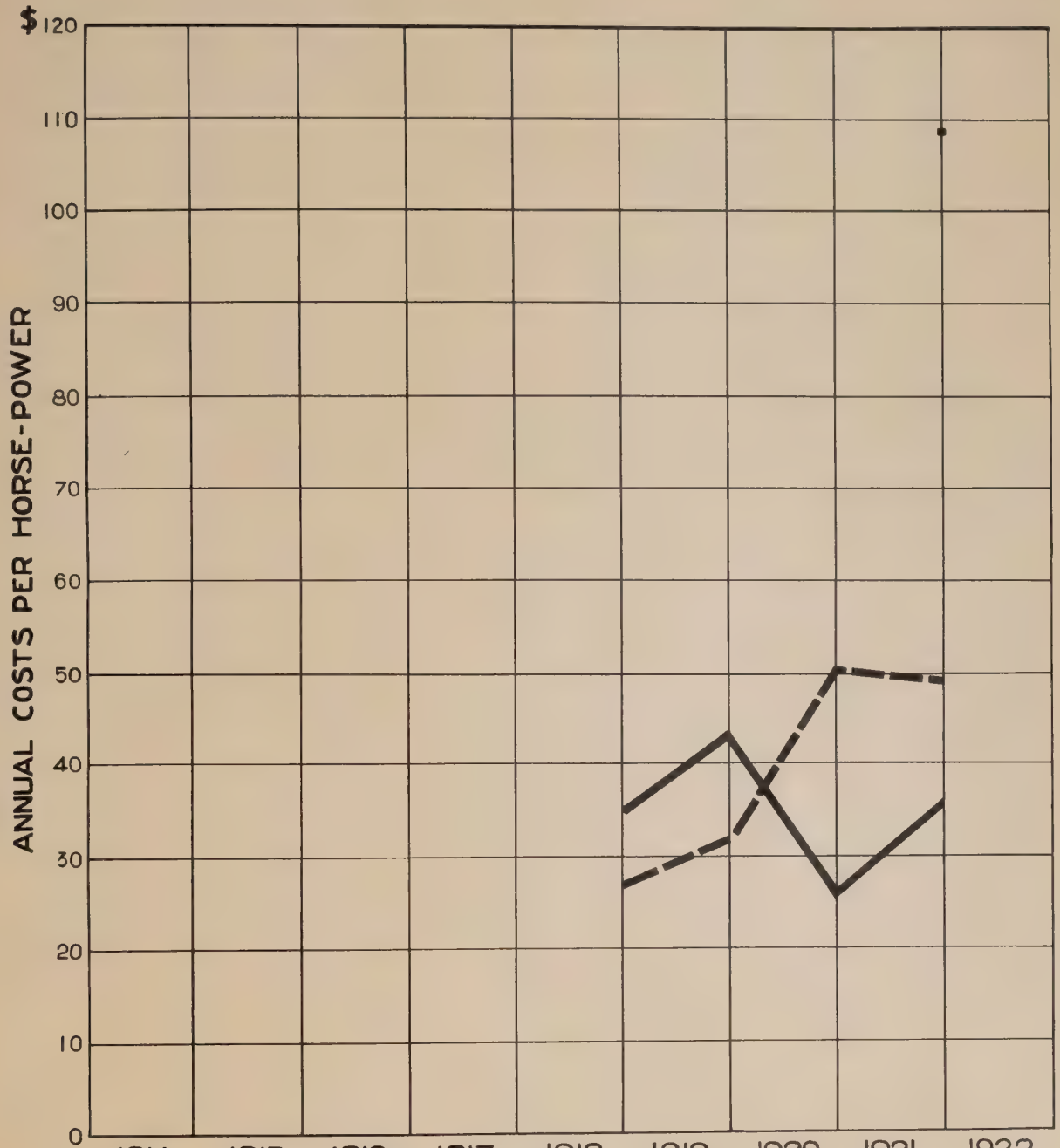
	1918	1919	1920	1921
H. P. Developed	$35.17	$43.56	$26.54	$36.30
H. P. Consumed	-	-	-	108.97
H. P. Billed	27.51	32.05	50.63	49.45

Table of Subdivided Costs per Horse-power Developed

	1918	1919	1920	1921
Operating Costs	$ 1.85	$ 3.52	$ 2.04	$ 2.63
Maintenance	3.14	4.64	2.16	4.22
Overhead and General Expense	3.84	7.53	5.50	6.53
Interest	15.86	18.55	12.91	13.76
Renewals	8.16	8.98	4.68	6.92
Sinking Fund	-	-	-	2.06
Contingencies	0.32	0.34	0.13	0.18
Total	$35.17	$43.56	$26.54	$36.30

Table of Sub-divided Costs per Horse-power Billed

	1918	1919	1920	1921
Operating Costs	$ 1.44	$ 2.59	$ 3.92	$ 3.58
Maintenance	4.02	3.41	4.12	5.74
Overhead and General Expense	3.01	5.54	10.50	8.90
Interest	12.41	13.65	22.91	18.75
Renewals	6.38	6.61	8.93	9.43
Sinking Fund	-	-	-	2.80
Contingencies	.25	.26	.26	.25
Total	$27.51	$32.05	$50.63	$49.45



COSTS PER H.P. CONSUMED
BILLED
DEVELOPED

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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM
TOTAL COSTS PER H.P. PER ANNUM, VARIOUS H.P. BASES

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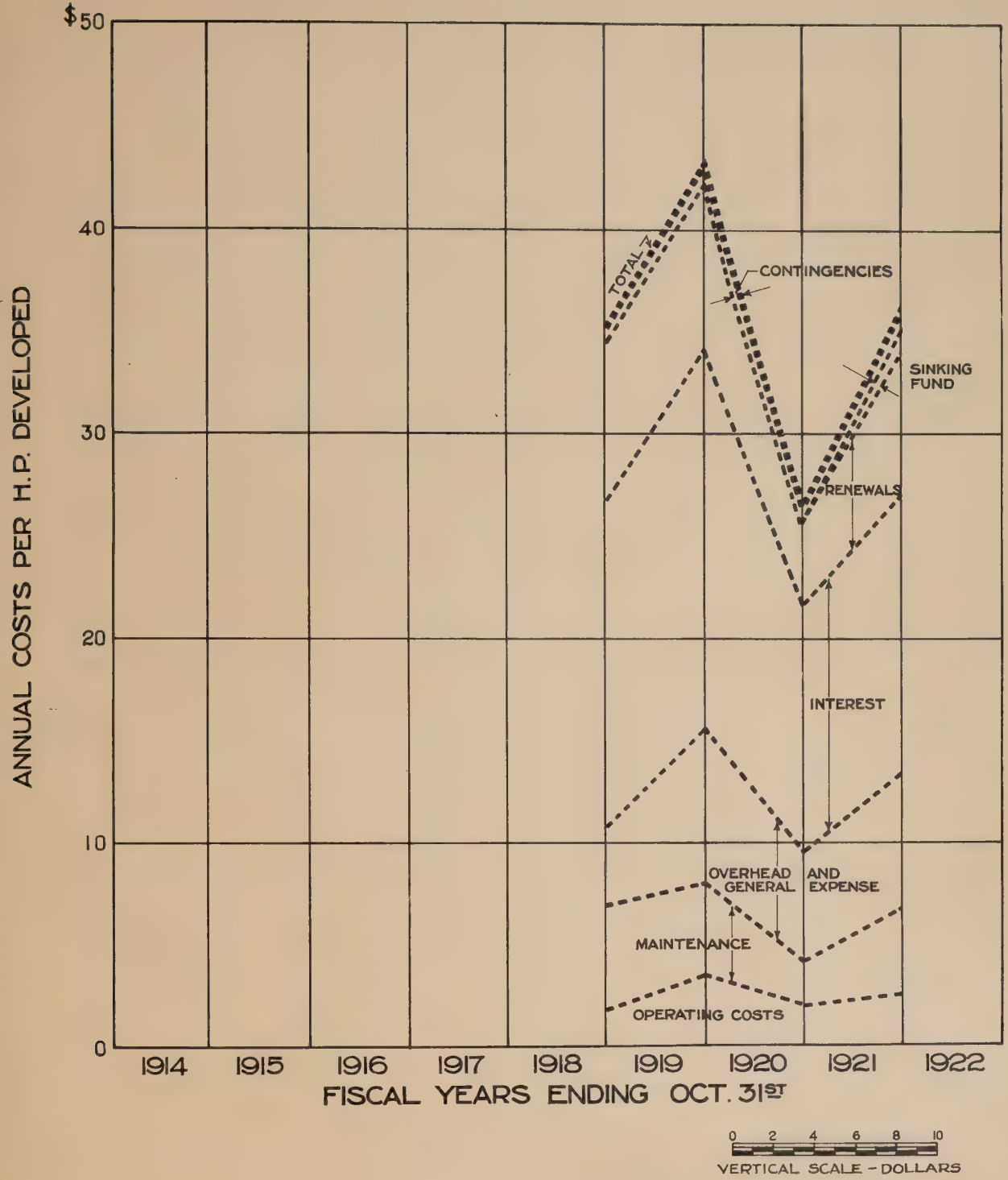

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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM

SUBDIVIDED COSTS PER ANNUM PER H.P. DEVELOPED

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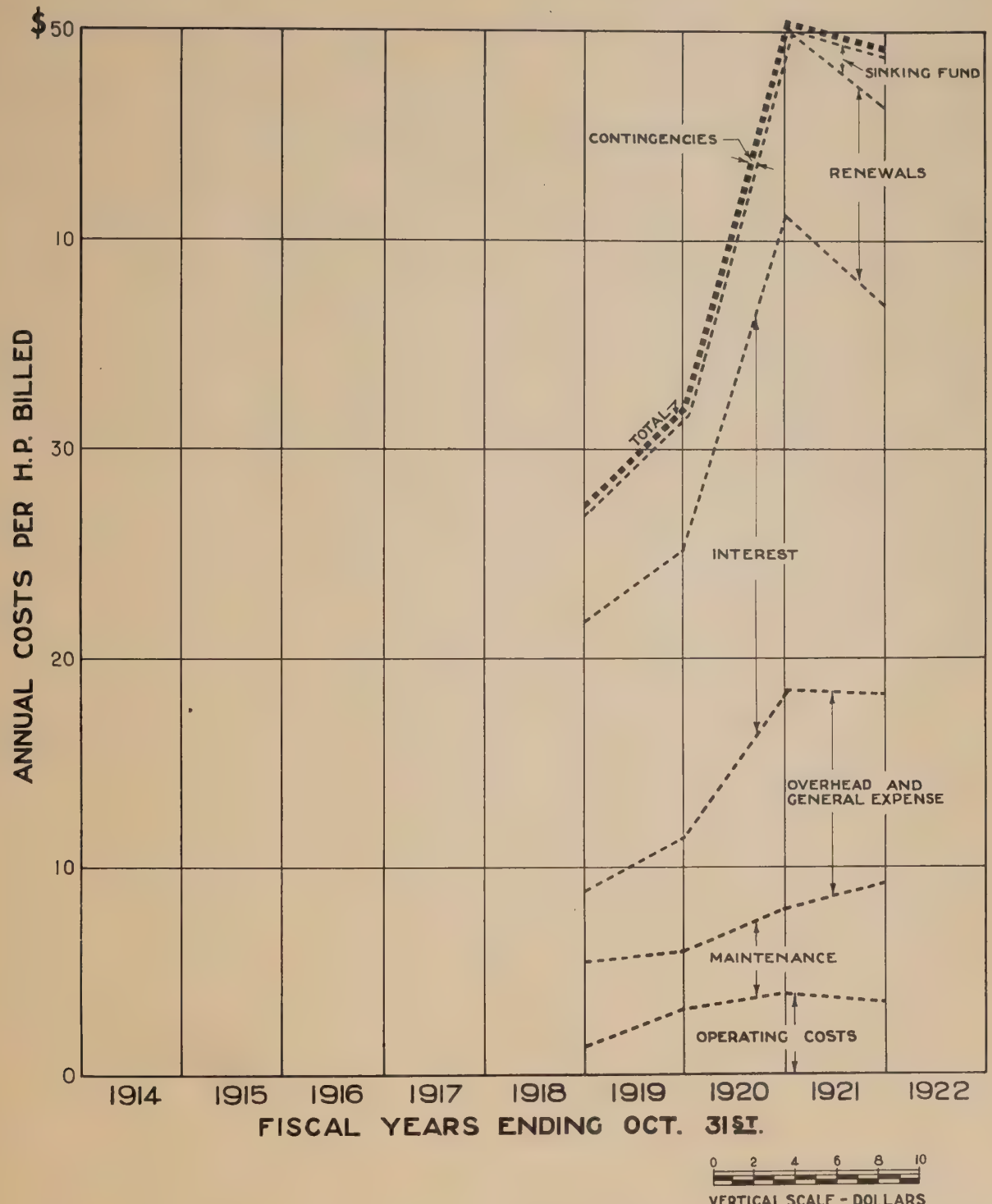

HYDRO-ELECTRIC INQUIRY COMMISSION
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ECONOMICS OF H. E. P. C. DISTRIBUTION SYSTEMS

EUGENIA SYSTEM

SUBDIVIDED COSTS PER ANNUM PER H.P. BILLED

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Kilowatt Hour Data and Annual Revenues and Costs per Kilowatt Hour.

The engineers of the Hydro-Electric Power Commission of Ontario state that prior to 1921 there is no reliable record of the number of kilowatt hours supplied to the Eugenia System. It is estimated by them that the total kilowatt hours consumed in 1921 for the Eugenia System amounted to 13,932,600. This being the only figure available up to that date, it is impracticable to plot diagrams for kilowatt hour consumption or costs, and the only thing possible is to show an analysis or subdivision of the total costs based on the average horse-power consumed and the kilowatt hours for 1921. For 1922 the kilowatt hours are about 17,250,000. The figures are as follows:

Table of Subdivided Costs per Average Horse-power and per Kilowatt Hour Consumed in 1921.

	Dollars per H.P.	Cents per K.W.H.
Operating Costs	$ 7.89	0.121
Maintenance	12.65	0.194
Overhead and General Expense	19.61	0.300
Interest	41.32	0.632
Renewals	20.78	0.318
Sinking Fund	6.17	0.094
Contingencies	0.55	0.008
Total	$108.97	1.667

Since it is the intention to supply power at cost the above figures represent the revenue per average horse-power consumed and the revenue per kilowatt hour for the year 1921, as well as the respective costs.

Summary

A summary of a number of the more salient points which have been studied and discussed in the foregoing report may be of advantage in continuing the consideration of the economics of the Eugenia System. They are as follows:

(1) The capital costs of the Eugenia System apparently contain nothing for intangible values and nothing for undeveloped properties. The capital costs of the Eugenia generating plant at first sight appear to show high costs per horse-power, the first development having cost about $200 per horse-power, but the extension made in 1918 and 1919, which doubled the capacity of the plant, at a cost of about $100 per horse-power for the extension, brings the total capital cost of the plant at the present time to about $150 per horse-power based on the usual rating of the Hydro-Electric Power Commission.

(2) Capital costs projected for 1922 and 1923 amounting to about $479,000 will make the total investment in the Eugenia System approximately $2,500,000 at October, 1923.

Of this contemplated expenditure about $219,000 is stated to be for additions to the Eugenia Falls plant, about $160,000 is stated to be for station and line extensions and betterments, and about $100,000 for expenditures on rural line already under application. The necessity for these expenditures should be determined.

(3) To facilitate future economic studies and to assist in operating efficiency it would be well to consider keeping accurate records of kilowatt hours used at each principal consuming point on the systems.

(4) The market for power has been well covered in the district. The density indicates a high percentage of consumers per capita of population. The demand for electricity apparently is still growing and indications are that further sources of power supply must soon be provided. The ultimate demand for power and the ultimate sources of supply should be considered in the near future because the local economical power sites will probably soon all be utilized.

(5) The reserve for renewals should be carefully considered in its relation to the recently revised estimated useful life for various portions of the property, and also adjusted to allow for the actual cost of money year by year.

(6) The reserve for contingencies has been called upon to replace properties damaged or destroyed by catastrophe, to nearly one-half of the total accumulations. This indicates that the reserve for contingencies might with advantage be increased and yearly results noted so as to eventually devise a proper yearly allowance for the fund.

(7) The operating records indicate that the System is being operated so as to supply power at cost, there being practically no difference between total revenues and total costs as shown on the Commission's books.

Walter J. Francis

Consulting Engineer.

Toronto, February 7, 1923.

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